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A POSSIBLE CORRELATION BETWEEN MAXIMA OF THE FAR ULTRAVIOLET SOLAR IRRADIANCE AND CENTRAL MERIDIAN PASSAGES OF SOLAR MAGNETIC SECTOR BOUNDARIES

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A POSSIBLE CORRELATION BETWEEN MAXIMA OF THE FAR
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OF SOLAR MAGNETIC SECTOR BOUNDARIES

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The question of the possible existence of a causal relationship between solar activity and meteorological phenomena has been the subject of many investigations. Recently there have been a series of papers reporting a connection between passages of solar magnetic field sector boundaries past the earth and certain meteorological phenomena. That work with ample references to past work has been reported in detail by Wilcox (1974) as a part of the proceedings of the "Symposium on Possible Relationships Between Solar Activity and Meteorological Phenomena."

It is the purpose of this work to describe the relationship which has been observed between enhancements in the far ultraviolet solar irradiance and the position of the solar magnetic sector boundaries. The ultraviolet observations have been made with the Monitor of Ultraviolet Solar Energy (MUSE) experiments which were launched aboard Nimbus 3 in April 1969 and Nimbus 4 in April 1970. The Nimbus 4 experiment is still operating. A summary of the circumstances of observed and well defined sector boundaries is contained in the work by Wilcox (1974).

The MUSE experiment has been described in detail by Heath (1973) and it consists of five broad band photometers which respond to solar radiation from 115 nm to 300 nm. Since the instrument was flown on the sun-synchronous Nimbus 3 and 4 satellites it has been possible to observe the intrinsic variability of the sun as an ultraviolet variable star. The persistent regions of solar

variability that are related to the rotation of long-lived active regions are shown in figure 1. Each point gives the solar longitude of the central meridian for the day number when the ultraviolet solar irradiance (principally - H Lyman alpha) was observed to be a maximum. The different symbols simply indicate the different active regions by virtue of their clustering about preferred solar longitudes. The nature of these curves is outside the scope of this paper and it used only to illustrate the fact that there are two very long lived regions of ultraviolet activity which were separated by about 180° in solar longitude in 1969.

Figure 2 shows the polarity of the interplanetary magnetic field as observed by spacecraft orbiting the earth (Wilcox and Colburn, 1972). The grey shaded area represents field directed away from the sun and the black indicates field directed toward the sun. The days on which the ultraviolet solar irradiance peaked during a solar rotation are indicated by the same symbols that were used in Figure 1.

Since there is a delay of about $4\frac{1}{2}$ days between the time a sector boundary is at central meridian on the sun and the time at which the solar wind carries it past the earth, (Wilcox, 1968) the sector boundaries shown in Figure 2 should be shifted backward by about $4\frac{1}{2}$ days to give the time at which they were near central meridian on the sun. When this is done one notes that the ultraviolet peaks marked with circles are very close to the time when an away - toward boundary was near central meridian, and the

ultraviolet peaks marked with X's are very close to the time when a toward - away boundary was near central meridian.

This relation is quantitatively displayed in Figure 3, which shows a histogram of the time in days of the ultraviolet peaks with respect to the time at which a sector boundary was near central meridian. A clustering of the ultraviolet peaks near the sector boundaries is evident. We reserve judgement on the small difference between away - toward and toward - away boundaries until more observations have been analysed.

Typical increases in the solar ultraviolet above the minimum during a solar rotation which were observed with the MUSE experiment in 1969 were typically: 25% at H Lyman alpha, 5% at 175 nm, and 1% at 295 nm. In terms of the equivalent width of the photometer channels this would correspond to increases above the minimum during a solar rotation of: $1.6 \text{ ergs/cm}^2 \text{ sec}$ at H Lyman alpha, $1.0 \text{ erg/cm}^2 \text{ sec}$ at 175 nm and $230 \text{ ergs/cm}^2 \text{ sec}$ at 295 nm. In other words typically variations per solar rotation are greater than the annual variation below 175 nm and less than above 175 nm. This representative increase associated with the solar rotation of ultraviolet active regions should be considered when considering possible physical causes to explain the observed correlations between passages of the solar magnetic sector boundaries past the earth and meteorological phenomena.

In summary, satellite observations of the sun over almost five years have shown that principally two ultraviolet active longitudes

have persisted over a significant portion of this observational period. A comparison between the positions of solar magnetic sector boundaries and ultraviolet enhancements of the sun seems to show, at least during the year of 1969, that the ultraviolet maxima tend to occur near the times when a solar sector boundary is near central meridian. An estimate of the magnitude of the variable ultraviolet solar energy input into the atmosphere resulting from the rotation of active solar longitudes is that for wavelengths less than 175 nm and down to H Lyman alpha it exceeds the annual variation whereas at longer wavelengths it is less. The total observed peak to peak variation in the ultraviolet irradiance from 120 to 300 nm over a solar rotation is typically at least $230 \text{ ergs/cm}^2 \text{ sec.}$

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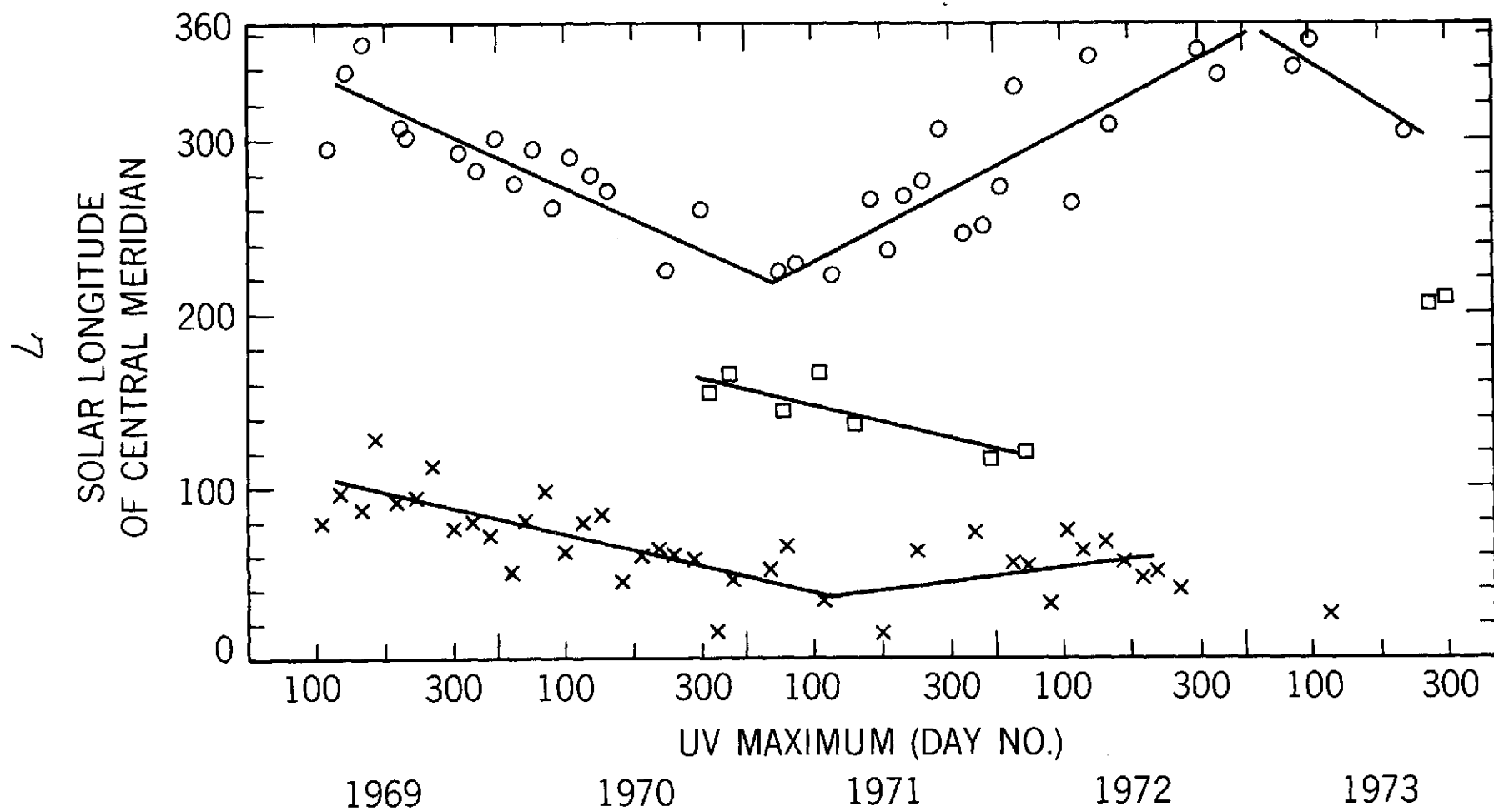
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Figure Captions

Figure 1: Carrington solar longitude of the central meridian on days of observed UV maximums in irradiance. The different symbols represent regions on the basis of groupings in longitude.

Figure 2: Representation of the sectors of the large scale solar photospheric magnetic field which is carried radially outward by the solar wind as it sweeps by the earth. The dotted or grey regions are for the away field and the black regions are for the towards field. Times of solar ultraviolet enhancements are indicated with the same symbols used in figure 1. The sector boundaries were near central meridian on the sun about 4 1/2 days before the times shown in the figure at which the boundaries were observed by spacecraft orbiting the earth.

Figure 3: Histogram of the time delay in days between an observed ultraviolet solar enhancement (UV max) and a corresponding central meridian passage of the solar magnetic field sector boundary.



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